

CHAPTER 2

TRANSPORTATION FUEL CONSUMPTION: EXISTING AND FUTURE BASELINE CONDITIONS

2.1 INTRODUCTION

An increasing focus is being placed in the United States on the use of petroleum in transportation, and Figure 2-1 shows the basis for the concern. Nationally, petroleum use in the electric utility, residential and commercial sectors decreased from 1973 to 1991. However, petroleum demand in the largest consumption sector, transportation, increased.

With respect to Hawaii, Figure 2-2 shows that in 1992, the transportation sector consumed 62 percent of the petroleum used in Hawaii, which represents 55 percent of the total energy used in the state. Table 2-1 shows energy use in Hawaii's transportation sectors between 1981 and 1993. Transportation energy demand in the ground, air and marine sectors increased at an annual rate of 4.78 percent between 1981 and 1990, although overall growth has moderated substantially since 1990, and demand has even declined substantially in the air sector since 1990.

Figure 2-3 shows energy use among the transportation sectors in 1992. Figure 2-3 shows that the air sector leads the others in total energy demand meaning that the large aircraft that travel long distances to and from Hawaii dominate energy demands. This occurrence is unique in the nation since the ground sector is the largest consumption sector in all other states.

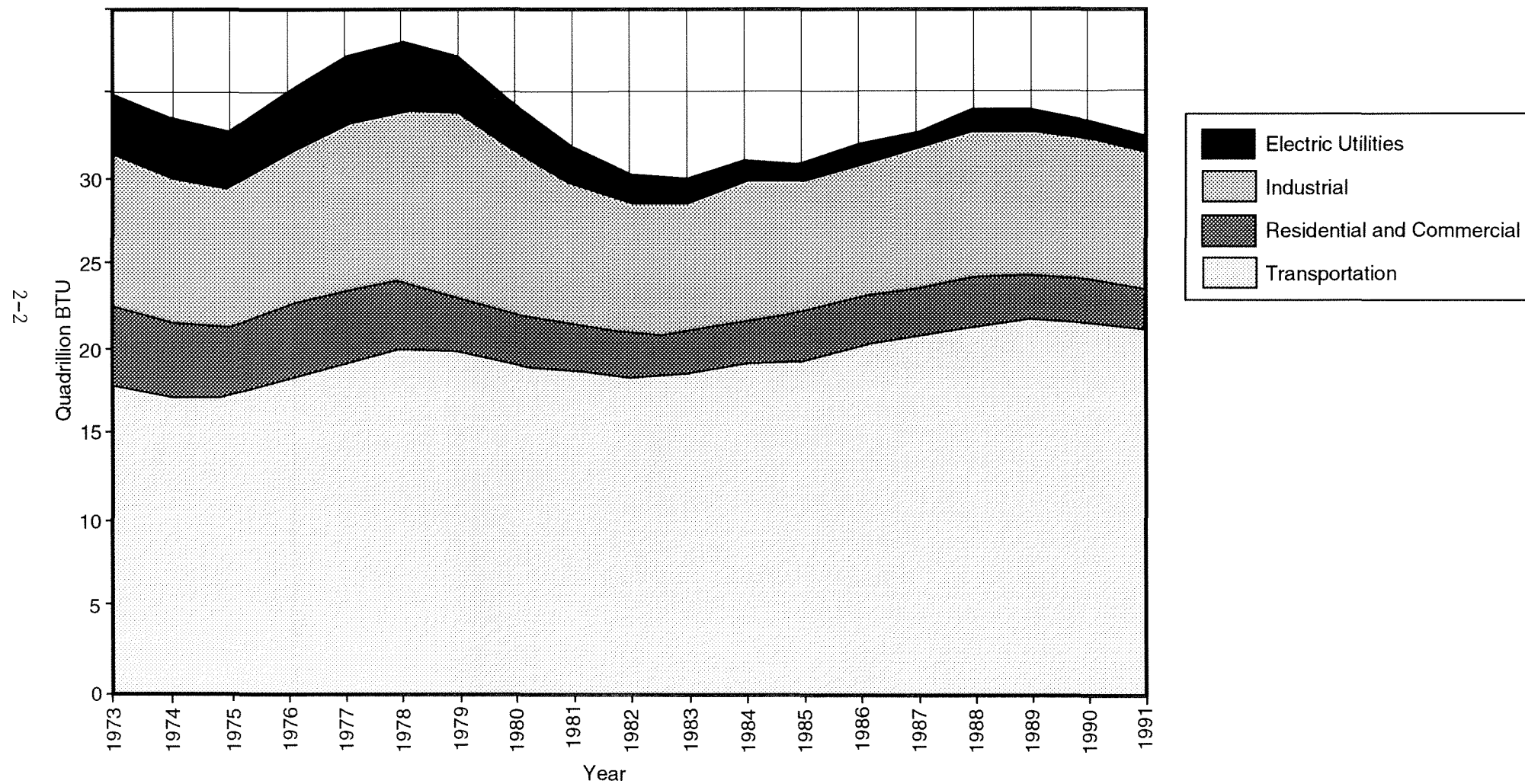
There are several concerns stemming from the facts above, including:

- Transportation energy demand has been increasing at a relatively rapid rate.
- Essentially all of the state's transportation energy is supplied by petroleum.
- The use of petroleum in the transportation sector has a large effect on the state's overall petroleum dependence.
- Hawaii is at the end of long petroleum supply chain which is vulnerable to disruption and price shocks.
- Hawaii has the highest retail gasoline prices in the nation.¹
- The money spent on crude oil and refined product purchased from out-of-state leaves the state.
- There is relatively little that the state can do to affect the energy requirements of the long-haul aircraft that dominate transportation energy demand.

¹ Based on a request from the Legislature, the Attorney General has been studying the possible causes of this situation.

Figure 2-1

U.S. Consumption of Petroleum by End-Use Sector 1973-1991



Source: U.S. DOE /EIA, 1992.

Table 2-1

**Statewide Fuel Consumption by Transportation Sector, 1981 to 1993
(Barrels)**

| Year | Ground¹ | | | Air¹ | Marine² | Total |
|-------------|---------------------------|----------------------|---------------------|------------------------|---------------------------|--------------|
| | <u>Gasoline</u> | <u>Diesel</u> | <u>Total</u> | | | |
| 1981 | 7,230,938 | 375,490 | 7,606,428 | 11,655,973 | 1,454,931 | 20,717,332 |
| 1982 | 7,293,915 | 411,986 | 7,705,901 | 11,297,081 | 1,328,834 | 20,331,816 |
| 1983 | 7,340,485 | 931,437 | 8,271,922 | 11,943,999 | 1,173,772 | 21,389,693 |
| 1984 | 7,676,422 | 426,011 | 8,102,433 | 11,566,914 | 1,379,865 | 21,049,212 |
| 1985 | 7,786,224 | 419,911 | 8,206,135 | 12,810,827 | 940,658 | 21,957,620 |
| 1986 | 7,956,467 | 460,811 | 8,417,278 | 14,361,110 | 1,092,277 | 23,870,665 |
| 1987 | 8,296,995 | 504,934 | 8,801,929 | 16,517,667 | 1,669,005 | 26,988,601 |
| 1988 | 8,523,478 | 501,358 | 9,024,836 | 16,703,696 | 2,804,995 | 28,533,527 |
| 1989 | 8,789,800 | 564,987 | 9,354,787 | 17,449,603 | 3,837,727 | 30,642,117 |
| 1990 | 8,937,677 | 589,588 | 9,527,265 | 17,875,947 | 4,121,900 | 31,525,112 |
| 1991 | 8,956,709 | 595,023 | 9,551,732 | 17,366,137 | 5,830,549 | 42,300,150 |
| 1992 | 9,074,248 | 625,917 | 9,700,165 | 16,938,141 | 4,384,245 | 31,022,551 |
| 1993 | 9,153,428 | 595,176 | 9,748,605 | 14,278,364 | 4,021,117 | 37,796,690 |

Compounded Annual Growth Rates:

| | | | | |
|-------------|-------|--------|--------|-------|
| 1981 - 1990 | 2.53% | 4.87% | 12.27% | 4.78% |
| 1990 - 1993 | 0.77% | -7.22% | N/A | N/A |

Sources:

- 1) Department of Taxation Data
- 2) State of Hawaii, DBEDT, Energy Division

Figure 2-2

Primary Petroleum Use Sectors, State of Hawaii, 1992

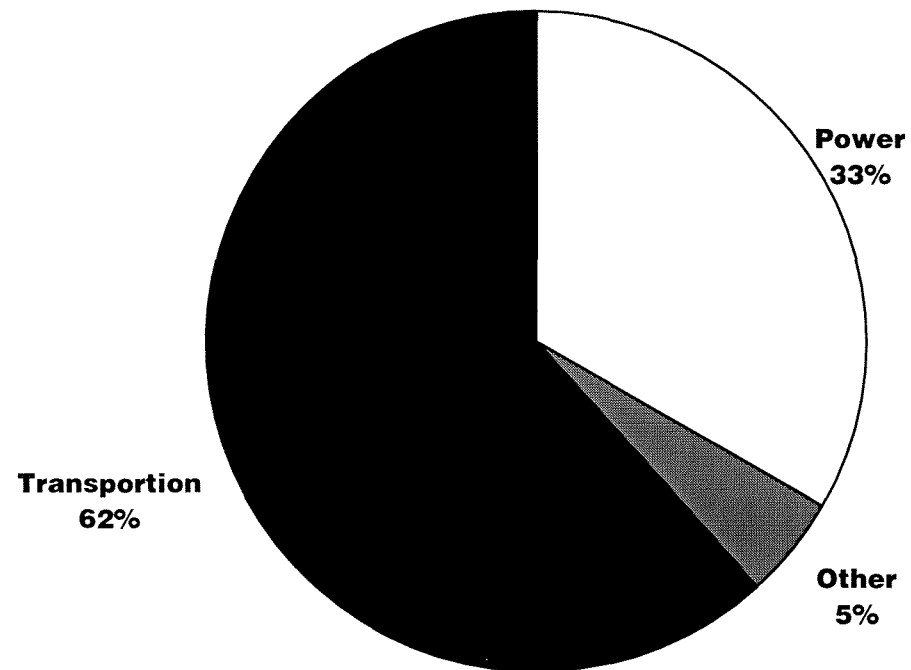
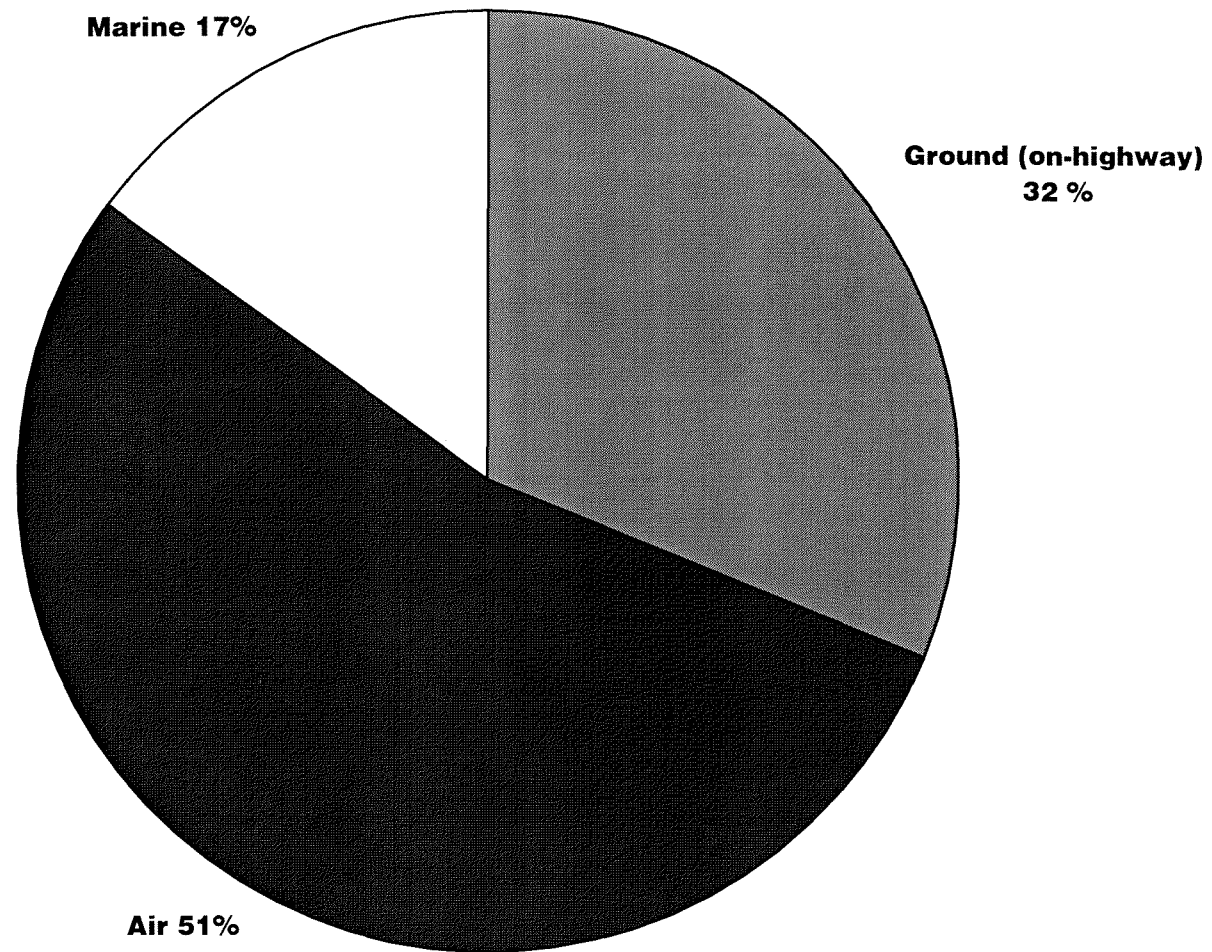


Figure 2-3

Fuel Consumption by Transportation Sectors, State of Hawaii, 1992



Sources:

- 1) State of Hawaii, DBEDT, Energy Division.
- 2) Department of Taxation.

transportation plans (the future “no-action” baseline). Chapter 3 then evaluates the energy savings potentially achievable through conservation, and Chapter 4 evaluates the potential for substituting “alternative fuels”² for petroleum.

This chapter projects future energy demand based on adopted transportation plans that have been developed by and for transportation agencies in the state.³ Major characteristics of the air, ground and marine transportation sectors have also been included in the analysis, such as fleet characteristics, fuel consumption levels, energy efficiency, and projected trends relevant to energy consumption.

The analysis begins with a review of historical data on transportation energy consumption to establish the current relationship between transportation activity and fuel demand. Since transportation plans provide projections of transportation activity, it is then possible to estimate future energy demand using the historical relationship between transportation and energy demand, adjusted by other relevant factors such as improvements in efficiency and effects of congestion. (More information on the approach followed for each sector is included in Appendix A-1.)

The analysis then proceeds to project transportation energy use for the years 1996, 1999, 2004 and 2014.⁴ This projection becomes the basis for such analyses as the potential for energy conservation and petroleum displacement.

This study’s reliance on existing transportation plans as the primary “driver” of future transportation energy demand is intentional, since it is not the purpose of this project to independently estimate future transportation activity. Development of a Hawaii-specific link between transportation and energy demand enables revisions of the energy demand projections whenever the underlying transportation projections are updated.⁵

The specific numerical values contained in the following projections are intended to provide an order of magnitude estimate. Their use in this report is consistent with this level of precision since they are only used to establish a framework to examine such topics as approximate size of the energy market, relationship of demand to the scale of production of alternative fuels and the timing of introduction of production facilities for alternative fuels. It will be seen later that even order of magnitude projections are useful in screening energy supply options.

Since the ground, air and marine sectors are characterized by different fuels, equipment, infrastructure and demand drivers, each sector is analyzed separately in the following sections.

² A detailed discussion of the definition of “alternative fuels” is deferred to Chapter 4 but the definition includes such transportation fuels as alcohols, propane, natural gas and electricity.

³ Most of these plans were developed in the late 1980’s and early 1990’s.

⁴ These are the analysis years established for the HES program.

⁵ In fact, the key transportation plans underlying the energy demand projections for the ground and air sectors are now being updated, with the revised plans expected to be available in 1995.

2.2 GROUND TRANSPORTATION

2.2.1 HISTORICAL DEMAND

Gasoline and diesel are the two primary fuels used for ground transportation. Gasoline is used in spark-ignition engines (primarily light duty vehicles) while diesel is used in compression-ignition engines (primarily heavy duty vehicles). There is a slight difference in the energy content of the two fuels with gasoline containing 109,000 to 119,000 Btu per gallon and #2 diesel containing 126,000 to 131,000 Btu per gallon (Tshiteya and Vermiglio, 1991).

Figure 2-4 summarizes ground sector energy demand based on Department of Taxation data from 1981 to 1993, distinguishing gasoline and diesel. (Appendix A-1 discusses the selected data sources, and Appendix A-2 provides historical data.) On a volumetric basis, gasoline use greatly exceeds diesel use, representing almost 94 percent of the liquid fuel volume used in the ground sector in 1993. When these volumes are converted to energy content (Btu's), however, diesel has been slowly increasing its market share (from 5.5 percent in 1981 to 7.3 percent in 1992).

Propane is also used as a transportation fuel, both on-highway⁶ and off-highway (e.g. forklifts). However, since the amount of propane used for transportation is less than 1 percent of the total amount of propane sold in the state, and propane contributes to less than one percent of the ground transportation fuel demand, propane is not included in the figures.

The total amount of fuel sold for ground transportation in 1993 was over 9.7 million barrels. In 1992, the ground sector represented 32 percent of the volume of transportation fuel sold in the state.

Between 1981 and 1990, ground sector energy demand grew at an average annual rate of 2.53 percent, but as shown in Figure 2-4, growth in demand has slowed since 1990. From 1990 to 1993, average annual growth has been about 0.77 percent.

For reference, annual average growth rates for some related parameters are:

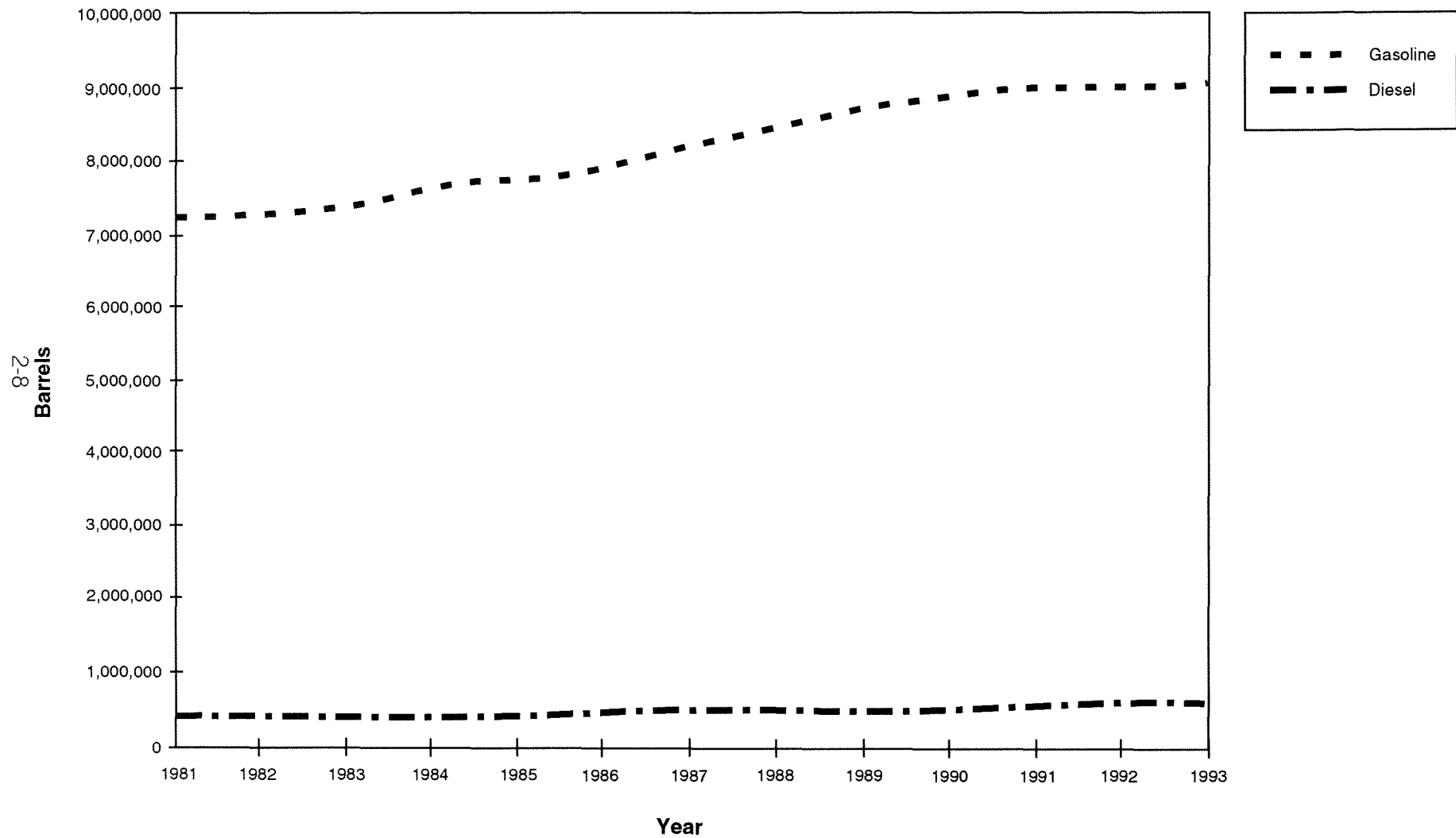
- Statewide "de facto" population⁷ from 1981 to 1990: 1.8 percent

⁶ For example, the City and County of Honolulu has over 100 propane-powered vehicles.

⁷ "De facto population" includes military personnel and their dependents, and visitors. "De facto population" was considered a reasonable parameter to compare to energy demand growth because this more encompassing definition of population would be expected to be more closely associated with levels of transportation activity than a more limited definition of population.

Figure 2-4

**Ground Sector Gasoline and Diesel Demand
Hawaii, 1981 - 1993**



- Total number of registered vehicles from 1981 to 1990: 3.7 percent⁸
- Total number of registered vehicles from 1989 to 1992: 0.89 percent

It is assumed that there is an association between vehicle miles traveled (VMT) and fuel consumption. (The projection methodology is based in part on projections of VMT to project future energy demand.) The number of registered vehicles is expected to continue to grow in association with population growth and other factors.⁹ It is notable that during the 1980's, energy demand grew much faster than the state's "de facto population."

Figure 2-5 shows ground sector transportation energy consumption by county for 1992. Over two-thirds (67%) of the ground sector energy demand is located on Oahu.

Service stations sell most of the ground transportation fuel (about 80 percent based on Energy Division records), emphasizing the importance of this type of retail outlet in planning for alternative fuels.

2.2.2 FLEET COMPOSITION

Figure 2-6 shows the classification of vehicles registered in the state in 1992. In 1992, passenger automobiles accounted for 79 percent of the vehicles registered in the state.

Additional information on fleet composition is provided in Chapter 4, which introduces the National Energy Policy Act (EPACT) and the Clean Cities Program. EPACT's provisions and the Clean Cities Program target vehicle fleets meeting certain criteria.

2.2.3 FUTURE DEMAND

Demand for ground transportation fuels is projected to increase as shown in Table 2-2. Appendix A-1 presents details of the approach. By 1996, ground sector energy consumption is projected to have increased by 5.5 percent over 1992 levels; by 1999 the increase is projected to be 8.8 percent over the 1992 level; by 2004 the increase is projected to be 13.2 percent over the 1992 level; and by 2014, demand is projected to be almost 21.7 percent more than the 1992 level. These projections are based primarily on increases in travel activity projected in each county's highway master plan (Neighbor Islands) or Regional Transportation Plan (Oahu). The parameter describing transportation activity varied among counties,¹⁰ so the annual percent increase projected for the parameter used by each county was used to drive the projections. In addition to transportation activity, the projections consider projected fuel efficiency improvements as presented in Argonne

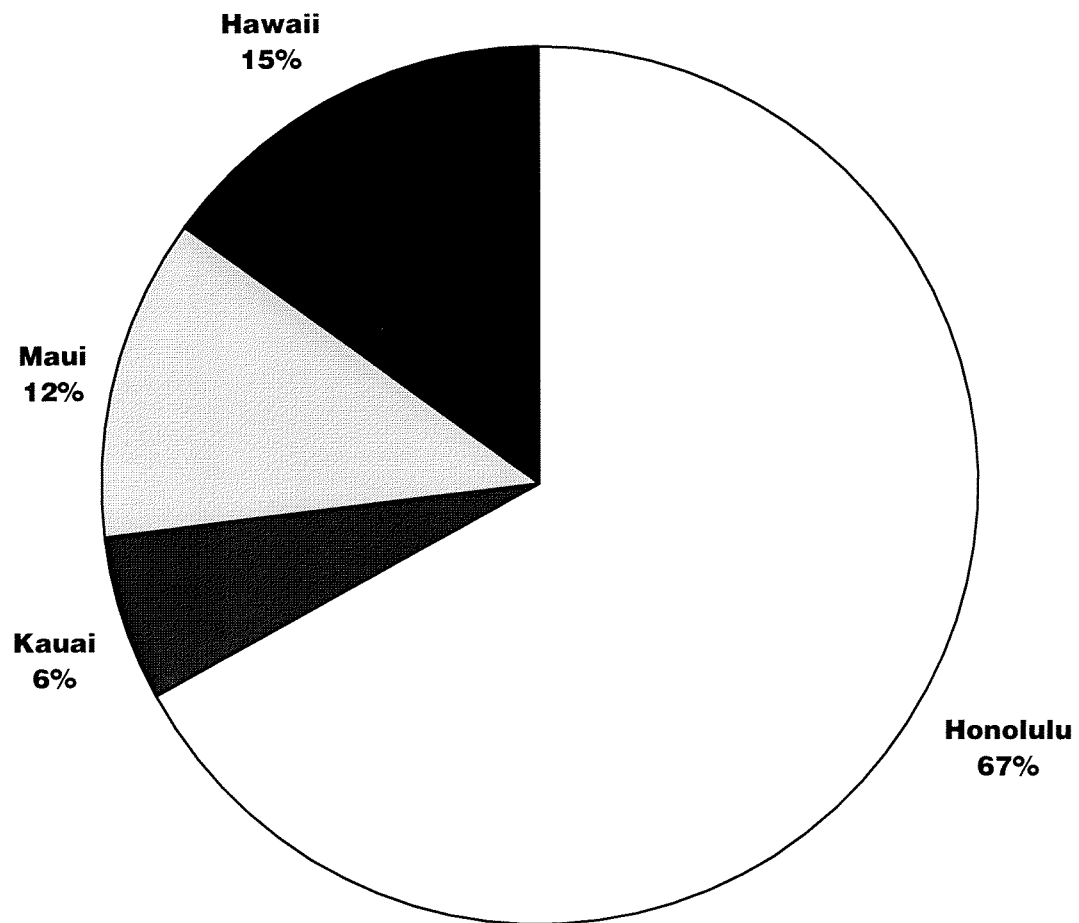
⁸ Each county has its own rate of increase in the number of vehicles registered in the county. For purposes of this study, the distribution of vehicles among the counties is important because it indicates where the demand for ground transportation fuels is located. The bulk of the market is located on Oahu, and although the Neighbor Islands have higher rates of growth in their populations, the dominance of Oahu in the state's ground sector energy demand is expected to continue. Based on historical data and an extrapolation of past trends, Oahu had 70 percent of the vehicles in 1990 and is expected to have 61 percent of the vehicles in 2004, when Maui and Hawaii would each have 15 to 16 percent, and Kauai would have about eight percent.

⁹ The State of Hawaii, Statewide Transportation Council and Department of Transportation (1991), projected an annual average increase in the number of registered vehicles of 2.12 percent for the period between 1992 and 1997.

¹⁰ The parameter describing transportation activity varied by county, and was daily vehicle trips, daily traffic volumes, or vehicle miles traveled depending on the county.

Figure 2-5

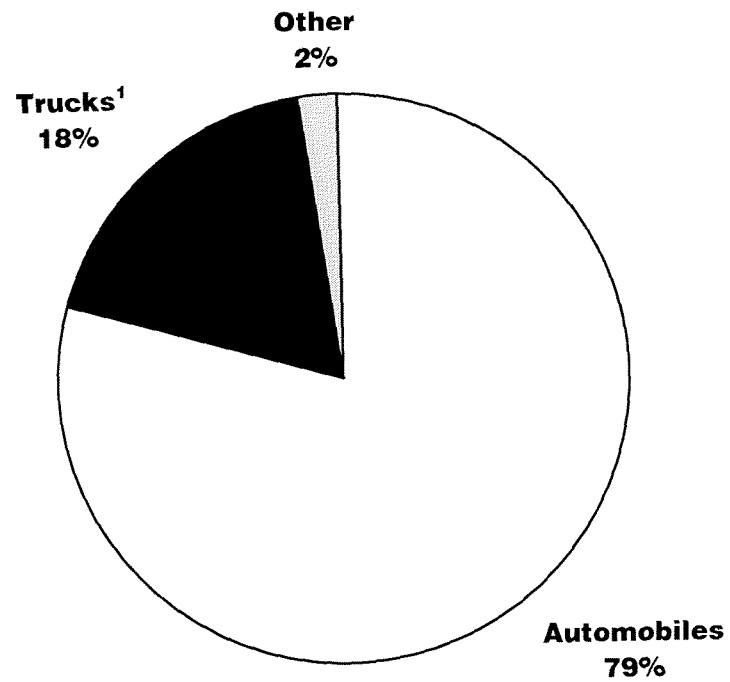
Ground Sector Fuel Consumption by County, 1992



Source: Department of Taxation Data.

Figure 2-6

**Distribution of Ground Vehicles
State of Hawaii, 1992**



Source: State of Hawaii, DBEDT, 1992.

Note: 1) Vans, pickups, and other trucks under 6,500 lb. in personal use, legally classified as passenger vehicles, are included in the totals for trucks.

Table 2-2
Estimation of Ground Sector Fuel Demand

| 1992 | | | | | | | |
|--------------------|--|----------------------|------------------------------|---|--|--|--|
| County | Number of Registered Vehicles in 1992 ¹ | Initial Demand (GEB) | Loss Due To Congestion (GEB) | Net Fuel Consumption (GEB) ² | Fuel Use Per Vehicle in 1992 (without congestion loss) | Percent Improvement in Fuel Efficiency from 1992 | Projected Annual Increase in Transportation Activity (percent) |
| Honolulu | 611,513 | 5,981,260 | 571,791 | 6,553,051 | 9.78 | 0% | 1.13% ³ |
| Maui | 110,003 | 1,081,995 | 103,436 | 1,185,430 | 9.84 | 0% | 3.93% ⁴ |
| Hawaii | 113,080 | 1,346,559 | 128,727 | 1,475,286 | 11.91 | 0% | 3.19% ⁵ |
| Kauai | 51,165 | 524,140 | 50,106 | 574,246 | 10.24 | 0% | 3.47% ⁶ |
| State Totals | 885,761 | 8,933,953 | 854,060 | 9,788,013 | 10.09 | 0% | |
| PROJECTIONS | | | | | | | |
| County | Projected Vehicles | Initial Demand (GEB) | Loss Due To Congestion (GEB) | Gross Demand (GEB) | Percent Improvement in Fuel Efficiency from 1992 | Net Fuel Consumption (GEB) | Percent Increase in Fuel Demand Compared to 1992 |
| 1996 | | | | | | | |
| Honolulu | 639,625 | 6,256,230 | 683,428 | 6,939,657 | 4% | 6,665,498 | 1.7% |
| Maui | 128,342 | 1,262,376 | 137,901 | 1,400,278 | 4% | 1,344,958 | 13.5% |
| Hawaii | 128,214 | 1,526,778 | 166,785 | 1,693,562 | 4% | 1,626,656 | 10.3% |
| Kauai | 58,645 | 600,766 | 65,627 | 666,393 | 4% | 640,066 | 11.5% |
| State Totals | 954,826 | 9,646,150 | 1,053,741 | 10,699,891 | | 10,277,179 | 5.0% |
| 1999 | | | | | | | |
| Honolulu | 661,555 | 6,470,721 | 739,246 | 7,209,968 | 7% | 6,711,501 | 2.4% |
| Maui | 144,076 | 1,417,136 | 154,807 | 1,571,944 | 7% | 1,463,266 | 23.4% |
| Hawaii | 140,880 | 1,677,601 | 183,260 | 1,860,861 | 7% | 1,732,209 | 17.4% |
| Kauai | 64,964 | 665,501 | 72,699 | 738,200 | 7% | 687,164 | 19.7% |
| State Totals | 1,011,475 | 10,230,959 | 1,150,013 | 11,380,973 | | 10,594,140 | 8.2% |
| 2004 | | | | | | | |
| Honolulu | 699,787 | 6,844,674 | 832,277 | 7,676,951 | 14% | 6,615,446 | 1.0% |
| Maui | 174,701 | 1,718,368 | 187,714 | 1,906,082 | 14% | 1,642,525 | 38.6% |
| Hawaii | 164,830 | 1,962,803 | 214,416 | 2,177,219 | 14% | 1,876,171 | 27.2% |
| Kauai | 77,045 | 789,261 | 86,219 | 875,480 | 14% | 754,426 | 31.4% |
| State Totals | 1,116,364 | 11,315,106 | 1,320,625 | 12,635,731 | | 10,888,569 | 11.2% |
| 2014 | | | | | | | |
| Honolulu | 783,007 | 7,658,660 | 1,018,338 | 8,676,999 | 21% | 6,877,325 | 4.9% |
| Maui | 256,865 | 2,526,536 | 275,998 | 2,802,534 | 21% | 2,221,268 | 87.4% |
| Hawaii | 225,639 | 2,686,908 | 293,517 | 2,980,425 | 21% | 2,362,263 | 60.1% |
| Kauai | 108,365 | 1,110,108 | 121,268 | 1,231,376 | 21% | 975,979 | 70.0% |
| State Totals | 1,373,876 | 13,982,213 | 1,709,121 | 15,691,334 | | 12,436,835 | 27.1% |

GEB = Gasoline equivalent barrels. 1 GEB = 4788000 British thermal units (lower heating value)

Sources:

- 1) "State Data Book, 1992," Table 507.
- 2) From Department of Taxation Data for on-highway fuel use.
- 3) "Oahu Regional Transportation Plan," OMPO, June 1991.
- 4) "Maui Long-Range Highway Planning Study - Island-Wide Plan - Final Report," SDOT, May 1991.
- 5) "Island of Hawaii Long-Range Highway Plan - Final Report," Parsons Brinckerhoff, May 1991.
- 6) "Kauai County Highway Planning Study - Final Report," SDOT, October 1990.

National Laboratory (1991), projected changes in each county's vehicle fleet composition, and projected levels of future congestion.

A 1.05 percent annual increase in Statewide ground sector transportation energy demand is projected between the years 1992 and 2014. This projection could be an overestimate since it

is driven by studies that were performed in the late 1980's, towards the end of a period of rapid growth in the state. Economic growth had slowed between 1990 and the date of completion of this report. The underlying transportation studies are presently being revised. The intent of this project is to examine relationships between measures of transportation activity and to develop methods of projecting energy and fuel demands implied by projected levels of transportation activity. It will be possible, therefore, using methodologies developed in this report, to revise and update energy demand projections to be consistent with the updated transportation projections.

The potential effects of conservation and the potential for petroleum displacement are discussed in Chapters 3 and 4.

2.3 AIR TRANSPORTATION

Of the three transportation sectors, air transportation has consistently been the largest fuel consumer from 1981 to 1993 (see Table 2-1).

Table 2-3 tabulates fuel use in the state's aviation sector from 1981 to 1993 based on Department of Taxation data.¹¹ Approximately 80 percent of the demand derives from outbound overseas flights, with the balance fueling interisland activity. From 1981 to 1990, growth occurred at an annual average rate of almost 4.87 percent. Between 1990 and 1993 demand decreased at an average annual rate of 7.22 percent.

Tables 2-3 and 2-4 show the aviation fuel demand calculations. Details of the projection method are discussed in Appendix A-1. The projection is primarily based on forecasts of interisland and overseas passenger and cargo volumes contained in Wilson Okamoto & Associates, Inc. (1990) adjusted by projected improvement in energy efficiency. The forecasts were prepared in 1990 during a period of rapid growth in passenger and cargo volumes. Actual data in subsequent years do not reflect the growth in the aviation section projected by Wilson Okamoto & Associates, Inc. (1990). Figure 2-7 plots both historic data and the projected level of demand for aviation fuel in the state.

Aviation fuel demand for fuel subject to taxation is projected to be about 17 million barrels by 1999 and about 21.6 million barrels by 2014, an annual growth rate of two percent. Outbound overseas flights are projected to represent over 80 percent of the total aviation fuel demand. Since these projections were developed based on taxed aviation fuel, these projections do not include aviation fuel which is not taxed, such as bonded fuels for international operations sold through duty free operations such as Hawaii Fueling Facilities Corporation (HFFC).

¹¹ Department of Taxation data was the approved data set for this analysis.

Table 2-4**Aviation Fuel Efficiency and Fuel Demand Forecast****1. Fueling Ratio¹**

| Year | Gallons / Passengers | |
|----------------------|-----------------------------|--------------------------|
| | Intrastate | Outbound Overseas |
| Average 1989 to 1993 | 15.3 | 66.8 |

2. Aviation Fuel Efficiency: Annual Rate of Change in Fuel Demand Projected by Others, 1985 - 2010²

| ANL | FAA | EIA | Average |
|------------|------------|------------|----------------|
| -1.61% | -1.73% | -1.88% | -1.74% |

3. Projected Fuel Efficiency

| Year | Gallons / Passengers | |
|---------------------------|-----------------------------|--------------------------|
| | Intrastate | Outbound Overseas |
| 1996 fuel efficiency rate | 14.520 | 63.370 |
| 1999 fuel efficiency rate | 13.770 | 60.120 |
| 2004 fuel efficiency rate | 12.610 | 55.070 |
| 2014 fuel efficiency rate | 10.580 | 46.200 |

4. Passenger Forecast³

| Year | Intrastate | Outbound Overseas | Total |
|-------------|-------------------|--------------------------|--------------|
| 1996 | 9,846,451 | 9,073,121 | 18,919,572 |
| 1999 | 10,374,454 | 10,031,967 | 20,406,421 |
| 2004 | 11,318,125 | 11,860,446 | 23,178,571 |
| 2014 | 13,470,787 | 16,578,036 | 30,048,823 |

Table 2-4

**Aviation Fuel Efficiency and Fuel Demand Forecast
(Continued)**

5. Fuel Demand Forecast (Barrels)

| Year | Intrastate | Outbound Overseas | Total |
|-------------|-------------------|------------------------------|--------------|
| 1996 | 3,404,059 | 13,689,611 | 17,093,670 |
| 1999 | 3,401,339 | 14,360,044 | 17,761,383 |
| 2004 | 3,398,132 | 15,551,304 | 18,949,436 |
| 2014 | 3,393,355 | 18,235,840 | 21,629,195 |

6. Aviation Fuel Demand Forecasts by Others (Barrels)

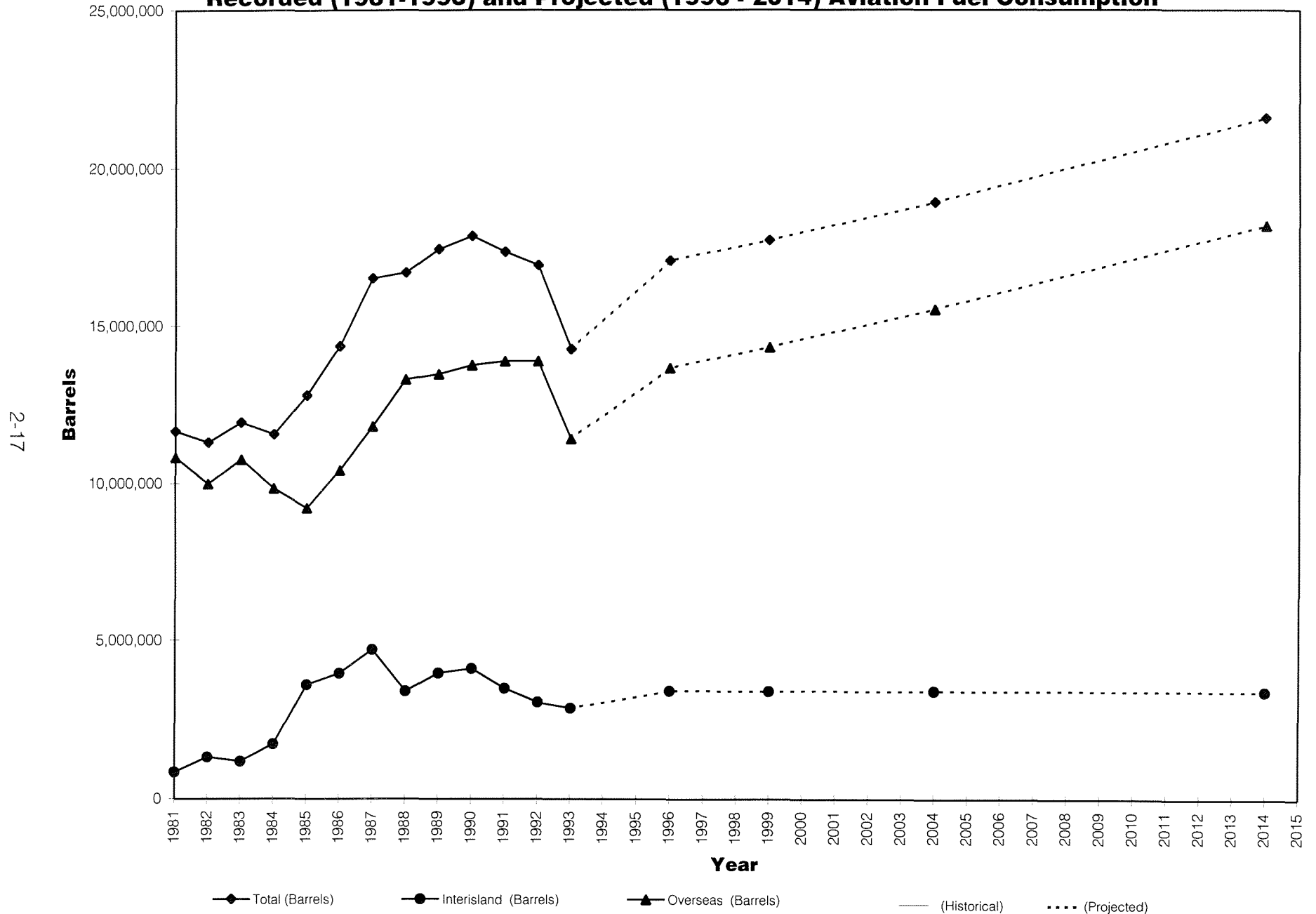
| Year | Intrastate | Outbound Overseas | Total |
|-------------|-------------------|------------------------------|-------------------------|
| 1995 | N/A | N/A | 21,754,000 ⁴ |
| 2010 | N/A | N/A | 31,645,500 ⁴ |
| 2010 | N/A | N/A | 33,000,000 ⁵ |

Notes:

- 1) Based on Department of Taxation Data and Department of Transportation passenger counts.
- 2) Based on Argonne National Laboratory (ANL) report: FAA = Federal Aviation Administration;
EIA = Energy Information Administration, Department of Energy.
- 3) Projected in "Hawaii Statewide Airport System Plan," adjusted to future analysis years.
- 4) "Energy Emergency Preparedness," Ed Noda Associates, August 1992.
- 5) "Phase II Report on a Relocation Program and Development Plan for Petroleum-Oil-Lubricants (POL)
Facilities in the Oahu Waterfront," Williams Brothers, November 1992.

Figure 2-7

Recorded (1981-1993) and Projected (1996 - 2014) Aviation Fuel Consumption



Source: Department of Taxation Data; projections by PBQD based on existing transportation plans.

These amounts are substantial.

This study's reliance on existing transportation plans as the primary "driver" of future transportation energy demand is intentional, since it is not the purpose of this project to independently estimate future transportation activity. Linking transportation and energy demand enables revisions of the energy demand projections whenever the underlying transportation projections are updated.

Since a study performed in 1990 was used to drive the projection, demand could be overestimated. Air transportation activity has slowed substantially between 1990 and the date of completion of this study.

2.4 MARINE TRANSPORTATION

Table 2-5 shows historical data on marine transportation fuel consumption based on DBEDT - Energy Division records, and Figure 2-8 plots this data along with the projected future demand. The records show an overall increase of about 183 percent from 1983 to 1990, the biggest percentage increase of the three transportation sectors. This corresponds to an annual growth rate of over 12.27 percent. In 1990, about 93 percent of the demand was for outbound overseas vessels, and the rest was for interisland purposes.

Although there are issues associated with information on petroleum product sales provided to DBEDT under Chapter 486E of the Hawaii Revised Statutes,¹² much of this dramatic growth is believed to have occurred and not be an artifact of the data. Local oil refiners increased sales of marine fuels to foreign fishing fleets and others through active marketing during this period. Because of the range that vessels may travel before refueling, merchant vessels employed in overseas trade can often continue beyond Hawaii without refueling. This option allows marine fuel procurement to be affected by such factors as:

- the energy cost differential between Hawaii and other ports of call, including the effects of changes in exchange rates;
- local marketing efforts in the marine bunkers market; and
- changes in actual levels of shipping activity.

Table 2-6 shows the calculations estimating future marine fuel use. The projections shown here are based on cargo tonnage projections. In subsequent studies, the factors identified above could be added to the analysis. Details of the approach are described in Appendix A-1. Total fuel demand is projected to increase from 4.1 million barrels in 1990 to 6.8 million barrels in 2014, including small recreational boats. However, since the types of factors listed above will continue to affect the local marine bunkers market, projections are

¹² State of Hawaii, DBEDT (1993) discusses some of the issues associated with this data in more detail.

Table 2-5

Intrastate and Outbound Overseas Cargo Tonnage and Fuel Bunkering Data

| Cargo Tonnage ¹ | | | | | | Marine Fuel Bunkering ² | | | | | |
|---|------------|------------|-------------------|------------|------------|--|--------------------|-----------------------------|--------------------|-----------------------|----------------------------|
| Calendar Year | Intrastate | % of Total | Outbound Overseas | % of Total | Total | Intrastate (Barrels) | Gallons/ Cargo Ton | Outbound Overseas (Barrels) | Gallons/ Cargo Ton | Grand Total (Barrels) | Average Gallons/ Cargo Ton |
| 1983 | 5,367,994 | 69.89% | 2,312,915 | 30.11% | 7,680,909 | 510,158 | 3.99 | 663,614 | 12.05 | 1,173,772 | 6.42 |
| 1984 | 5,206,745 | 70.06% | 2,224,602 | 29.94% | 7,431,347 | 520,909 | 4.20 | 858,956 | 16.22 | 1,379,865 | 7.80 |
| 1985 | 5,161,665 | 68.50% | 2,373,538 | 31.50% | 7,535,203 | 418,241 | 3.40 | 522,417 | 9.24 | 940,658 | 5.24 |
| 1986 | 5,382,155 | 68.80% | 2,440,370 | 31.20% | 7,822,525 | 574,316 | 4.48 | 517,961 | 8.91 | 1,092,277 | 5.86 |
| 1987 | 6,272,667 | 71.65% | 2,481,469 | 28.35% | 8,754,136 | 670,425 | 4.49 | 998,580 | 16.90 | 1,669,005 | 8.01 |
| 1988 | 7,091,952 | 72.80% | 2,649,390 | 27.20% | 9,741,342 | 338,871 | 2.01 | 2,466,124 | 39.09 | 2,804,995 | 12.09 |
| 1989 | 7,269,413 | 72.90% | 2,701,904 | 27.10% | 9,971,317 | 275,208 | 1.59 | 3,562,519 | 55.38 | 3,837,727 | 16.16 |
| 1990 | 8,195,157 | 76.48% | 2,520,700 | 23.52% | 10,715,857 | 296,913 | 1.52 | 3,824,987 | 63.73 | 4,121,900 | 16.16 |
| Annual Average: | | | | | | | 3.21 | | 27.69 | | 9.72 |
| 1989 - 1990 Average: | | | | | | | 1.56 | | 59.55 | | |
| Intrastate and Overseas Cargo Tonnage Forecast ³ | | | | | | Marine Fuel Demand Forecast ⁴ | | | | | |
| | | | | | | Interstate (Barrels) | Gallons/ Cargo Ton | Outbound Overseas (Barrels) | Gallons/ Cargo Ton | Grand Total (Barrels) | |
| 1996 | 11,138,209 | 78.52% | 3,047,207 | 21.48% | 14,185,415 | 413,705 | 1.56 | 4,295,111 | 59.20 | 4,708,816 | |
| 1999 | 12,683,916 | 79.69% | 3,231,658 | 20.31% | 15,915,574 | 465,077 | 1.54 | 4,541,248 | 59.02 | 5,006,325 | |
| 2000 | 15,260,095 | 81.17% | 3,539,077 | 18.83% | 18,799,172 | 555,903 | 1.53 | 4,948,809 | 58.73 | 5,504,712 | |
| 2014 | 20,412,453 | 83.09% | 4,153,915 | 16.91% | 24,566,368 | 738,736 | 1.52 | 5,750,205 | 58.14 | 6,488,941 | |

Sources:

- 1) *DOT/HD Cargo Statistics -- Tonnage in Short Tons, Summary by Port and Fiscal Year,* 01/30/92.
- 2) State of Hawaii, Department of Business, Economic Development & Tourism, Energy Division.
- 3) PB projections based on regression analysis.
- 4) See Table 2-6.

Table 2-6
Marine Fuel Demand Forecast

1. Fuel Utilization on Rate (average of 1989 and 1990)

(Sources: State of Hawaii, DBEDT, Energy Division; State of Hawaii, DOT, Harbors Division)

| Gallons / Cargo Ton | |
|----------------------------|--------------------------|
| Intrastate | Outbound Overseas |
| 1.56 | 59.56 |

2. Fuel Efficiency Improvement Factor

(Source: Argonne National Laboratory, 1991)¹

Average annual percentage change from 1985 to 2010: 0.10%

3. Forecast of Fuel Utilization Rate (from step 2)

| Year | Gallons / Cargo Ton | |
|-------------|----------------------------|--------------------------|
| | Intrastate | Outbound Overseas |
| 1996 | 1.55 | 59.20 |
| 1999 | 1.54 | 59.02 |
| 2004 | 1.53 | 58.73 |
| 2014 | 1.52 | 58.14 |

4. Marine Cargo Forecast (PBQD Projections)

| Year | Cargo (Tons) | | |
|-------------|---------------------|--------------------------|--------------|
| | Intrastate | Outbound Overseas | Total |
| 1966 | 11,138,209 | 3,047,207 | 14,185,416 |
| 1999 | 12,683,916 | 3,231,658 | 15,915,574 |
| 2004 | 15,260,095 | 3,539,077 | 18,799,172 |
| 2014 | 20,412,453 | 4,153,915 | 24,566,368 |

5. Fuel Demand Forecast (from steps 3 and 4)

| Year | Fuel (Barrels) | | | |
|-------------|-----------------------|--------------------------|-----------------------------|--------------|
| | Intrastate | Outbound Overseas | Recreational Boating | Total |
| 1996 | 413,705 | 4,295,111 | 84,000 | 4,792,816 |
| 1999 | 465,077 | 4,541,248 | 84,000 | 5,090,325 |
| 2004 | 555,903 | 4,948,809 | 84,000 | 5,588,712 |
| 2014 | 738,736 | 5,750,205 | 84,000 | 6,572,941 |

Note:

1) "Forecast of Transportation Energy Demand Through the Year 2010," Argonne National Laboratory (1991).

likely to be imprecise, and continued volatility in this consumption sector should be expected as foreign exchange rates and shipping activities change.

2.5 MILITARY TRANSPORTATION

Accurate and comprehensive information on fuels used by the military for transportation and other uses is not readily available. The Department of Taxation data does not address military consumption separately, and although information was requested from the military, complete information for all branches of service and all installations in the state could not be obtained. The only remaining data source is DBEDT - Energy Division records fuel sales, as reported under Chapter 486-E of the Hawaii Revised Statutes (HRS 486-E). These reports include separate categories for sales of fuel to the military. However, a substantial amount of in-state military fuel use could occur without being reported through this mechanism, which only tabulates purchases made on the local market and therefore excludes significant interstate and international shipments.

The data suggest that military fuel purchases on the local market have declined steadily from about 6.6 million barrels in 1981 to 2.6 million barrels in 1990, an overall decrease of 62 percent which corresponds to an average annual decrease of 9 percent. Possible reasons for this decrease are many, and could include:

- actual decreases in military transportation activity;
 - reductions in military forces;
 - changes in refueling patterns; and/or
 - less procurement of fuel through channels that report fuel sales under the HRS 486-E system.
-

2.6 SUMMARY

2.6.1 HISTORICAL TRENDS

The total amount of petroleum used by all sectors (transportation and non-transportation) in the State of Hawaii increased from about 42.6 million barrels in 1981 to about 48.9 million barrels in 1991. This represents a compounded annual rate of increase over the period of approximately 1.68 percent.

Fuels consumed by the ground, marine and air transportation sectors increased from about 20.7 million barrels in 1981 to about 31.5 million barrels in 1990. The average annual rate of

change over this period was approximately 4.78 percent, a substantially greater rate of increase than total energy consumption in the state.

Average annual increases for the three modes between 1981 and 1990 were:

- ground: 2.53 percent
- air: 4.87 percent
- marine: 12.27 percent

However, since 1990, growth in demand has moderated substantially, and demand even decreased by 7.22 percent in the air sector between 1990 and 1993.

Demand by the military for transportation fuels from vendors that report under the HRS 486-E system decreased at an annual average rate of 9.1 percent between 1981 and 1990.

2.6.2 THE “FUTURE NO-ACTION BASELINE”

Total ground, air and marine transportation fuel demand is projected to increase to 40 million barrels by 2014, which corresponds to an annual rate of increase of 1.75 percent (see Table 2-7 and Figure 2-8). The aviation sector is projected to continue as the dominant sector.

Projected annual increases in energy demand for the three modes between 1992 and 2014 are:

- ground: 1.05 percent
- air: 2 percent
- marine: 2.37 percent

It is possible that the transportation studies underlying these projections overestimate future travel, which would cause an overestimation of energy demand. In the ground and air sectors (but not the marine sector), the relevant studies are being updated and should be available in 1995.

Table 2-7

**Energy Demand Projections
(Barrels)**

| Year | Ground | Air | Marine | Total |
|------|------------|------------|-----------|------------|
| 1993 | 9,748,605 | 14,278,364 | 4,021,117 | 28,048,086 |
| 1996 | 10,058,922 | 17,093,670 | 4,792,816 | 31,945,408 |
| 1999 | 10,379,116 | 17,761,383 | 5,090,325 | 33,230,824 |
| 2004 | 10,935,584 | 18,949,436 | 5,588,712 | 35,473,732 |
| 2014 | 12,139,621 | 21,629,195 | 6,572,941 | 40,341,757 |

Compounded Annual Growth Rates:

1993-2014 1.05% 2.00% 2.37% 1.75%

Sources: Parsons Brinckerhoff, 1994

**Figure 2-8
Projected Energy Demand
(Barrels)**

